

REPORTS
ON
PUBLIC HEALTH AND
MEDICAL SUBJECTS.

No. 8.

SMALL-POX AND VACCINATION.



MINISTRY OF HEALTH.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

1921.

Price 3d. Net.

SMALL-POX AND VACCINATION.

Experience of Small-pox in England and Wales,

Liability of this Country to its introduction.—Small-pox is one of the most infectious diseases. It is always present in some parts of the world and may at any time be introduced into England from abroad. Such introductions occur notwithstanding the vigilance of our Port Sanitary Authorities, as the disease has a long incubation period, *i.e.*, twelve to fourteen days elapse between the time that a person becomes infected and the time that he shows the first symptoms of the malady, and during the incubation period until the onset of the illness he remains to all intents and purposes in good health. Thus a person who contracts the infection of small-pox in Cairo or New York can travel to and land in England and not show any signs of the disease until after he has reached his home in this country. We are therefore always liable to occurrence of cases of small-pox, and it is never possible to say when or where the next outbreak will occur.

Epidemic Small-pox: Variations in type.—Small-pox is a disease that recurs in epidemic form from time to time, and during these epidemic outbursts it spreads rapidly over wide surfaces of the world and its infectiousness is largely increased. Although the infectivity of the disease is enhanced, the virulence of the infection is not always increased, so that in one epidemic the proportion of fatal cases to the total number of known cases of small-pox may be very high, while in another epidemic the proportion of deaths to cases may be small. That the severity of the disease might vary in different epidemics within very wide limits was well known to early writers on small-pox; and at the present time more than one type of the disease exists. On the American continent, although severe cases of small-pox occur, the prevailing type is mild and the fatal cases are few. In a recent introduction of this type of disease into England some 90 cases occurred without a single death. In the East the type is severe, and when imported into this country the disease maintains this character.

Small-pox in Pre-vaccination Days.—In this country in pre-vaccination days it was accepted as an established fact that every one would suffer attack by small-pox at some period of his life, and that the date of this attack depended on opportunity of infection afforded by recurring periodic prevalence of the disease. An instance of this belief that an attack by small-pox was inevitable is shown in the records of the small town of Ware, where in the year 1722 small-pox became epidemic. Out of a population of 2,515 at the beginning of the epidemic, 1,601

had previously had small-pox, leaving 914 susceptible persons. Among these there were during the epidemic 612 cases with 72 deaths, and at the end of the epidemic there were 302 persons who, having escaped the attack, are referred to in the record as "*to have the small-pox.*"

When small-pox appeared in a district in pre-vaccination days the population was sharply divided into two classes, viz., those who had survived an attack by small-pox and those who had not suffered from the disease. Occasionally a person who had suffered an attack, and probably a mild attack, in infancy, might be again attacked by small-pox in the later years of life when the protection afforded by the previous attack had passed away, but as a general rule second attacks by the disease were rare. The susceptible population were chiefly those who had been born since the last epidemic prevalence of small-pox, and thus the incidence of the disease fell mainly on children. These old records show not only the severity of the epidemics but, what is of great interest, viz., how small a proportion of the total population had not already suffered previous attack by small-pox. Thus, on 1st January, 1775, at Chester (which had at that time a population of 14,713 persons), when small-pox had been epidemic in the year 1774, it was ascertained that 1,060 persons, or about 7 per cent. of the population, had not had the small-pox during the previous year or at any earlier time.

Age incidence of Small-pox in Pre-vaccination Days.—The old death registers show that a very large number of the deaths occurred among children under two years of age. At Chester, when the epidemic of small-pox occurred in 1774, 1,202 persons were attacked by the disease, and of these 202 died. All the 202 deaths were children under 10 years of age, and a quarter of them were under one year. In Warrington, in 1773, with an estimated population of 8,000, an epidemic of small-pox occurred, and 211 deaths resulted: all the fatal cases were among children under 9 years of age. In Kilmarnock, between 1728 and 1763, estimated population 3,350 to 4,200, there were 622 deaths from small-pox; in respect of nine of these deaths the ages are not given, but of the remaining 613 only 7 were above 10 years of age.

It was estimated by Daniel Bernouilli, a distinguished mathematician writing in 1760-5, that small-pox carried off the thirteenth or fourteenth part of each generation.

Inoculation of the Small-pox.—The fixed belief that every person must suffer attack by small-pox at some period of his life led to the adoption of the practice of inoculation with the virus of the disease. By this means persons who had not suffered attack by the natural small-pox were able to decide beforehand to undergo the disease at a time that suited their convenience. This method of acquiring the small-pox artificially was introduced in 1721, and in the hands of certain inoculators it was success-

ful in producing a mild attack of small-pox. Severe and even fatal attacks could not be excluded and persons undergoing inoculation were infectious, *i.e.*, capable of spreading the natural disease to other persons who were not protected by previous attack by small-pox. With the introduction of vaccination the practice of inoculating the small-pox fell into desuetude, and finally by an Act of Parliament, passed in 1840, the practice was made illegal.

Effects of Small-pox.—It was not only the dread of death that caused small-pox to be so much feared. Among those who survived the attack there were many who were rendered blind or deaf or who had suffered disfigurement of the features and other injuries during the course of the disease that resulted in permanent infirmity and proved contributory causes of early death.

So much was this the case that in pre-vaccination days in England, as in other countries, men declined to marry maidens who had not had small-pox. The maid who had passed through an attack of small-pox possessed many advantages not enjoyed by her sister who had not had the disease. She was not likely to have a second attack and her chances of living to a reasonable age could be estimated with some degree of certainty. True, she might not have escaped entirely unscathed, for few ever did who recovered; her beauty might be impaired, her skin deeply pitted and scarred, and her features partly destroyed. These conditions were preferable, however to blindness, deafness and permanent invalidism which too often resulted from an attack of small-pox.

The history of small-pox is a history of protection for those who have been attacked, and the fact of natural immunity became deeply rooted in the public mind. It is that fact which lies at the basis of vaccination.

Vaccinia, or Cow-pox.—"Vaccinia," or cow-pox, is a disease affecting milch cows, and it is characterised by an eruption on the udder and teats. The disease can be communicated from the cow to man, and from man to man, but only by inoculation; it is not infectious.

The Introduction of "Vaccination."—At the close of the eighteenth century, and probably at an earlier date, in districts where cow-pox had appeared, a belief existed among the dairy-folk that those who had taken the cow-pox never took the small-pox. In 1774, one Jesty, a Dorsetshire farmer, had purposely introduced the matter of cow-pox into the human subject, inoculating his wife and sons with the view of protecting from small-pox.

It was not until the summer of 1798, when Edward Jenner published his "Inquiry into the Causes and Effects of the Variolæ Vaccinæ," that the practice of inoculating with the matter of cow-pox, or vaccination as it was subsequently

called, became general. The practice rapidly spread, and prevailed widely in this country and other parts of western Europe during the first quarter of the nineteenth century. It was, beyond all question, so adopted in the genuine belief that it afforded protection against small-pox.

The publication by Jenner of his discovery naturally gave rise to much controversy, and on His Majesty's command the Royal College of Physicians of London made a report on the subject of vaccination to the House of Commons in 1807. The inquiry was a thorough one, no facts being regarded as proved but those stated from actual observation. The College as the result of the inquiry felt it to be their duty strongly to recommend the practice of vaccination.

Decrease in Small-pox Mortality.—The first quarter of the nineteenth century was characterised in this and in other countries by a striking decrease of small-pox mortality. It must be borne in mind that at the time of the introduction of vaccination a large proportion of the population was protected by previous attacks of small-pox, either natural or inoculated, and that the amount of vaccination adequate to afford great protection in the earlier years of the century ceased to be adequate for the later years as those who had suffered attack by small-pox were removed from the population in the natural course of events by death.

In 1837 the present system of registration of deaths commenced in England; and from that date, with the exception of a few years in which the small-pox deaths were not separately abstracted, a more exact statistical record of small-pox mortality is available than existed in antecedent years. (*Vide* Appendices I. and II.)

The Influence of improved Sanitation.—It is reasonable to suppose that overcrowding of houses on land and of persons in houses, and that uncleanness of persons and of their surroundings, would favour the spread of infection from person to person; and the argument has been advanced that improved sanitary conditions would tend to lessen the fatal results and that in consequence the mortality from small-pox would be correspondingly lowered. Compared with 100 years ago, the country has purer water supplies and better sewerage systems, various Public Health Acts have been passed under which medical officers of health and sanitary inspectors have been appointed, the lighting and ventilation of dwellings have been improved, and power has been given to local sanitary authorities to deal with nuisances, and it is now more generally recognised that certain diseases are infectious. Other changes, however, have been in operation. There are greater facilities for travelling and greater interchange of persons between districts resulting in increased opportunities for spread of infection.

But when small-pox breaks out, it visits with strict impartiality healthy and unhealthy districts, and the incidence of attack and death falls on rich and poor alike subject only to one condition—the absence or the presence of the protection afforded by vaccination.

Comparison of the mortality statistics of the latter part of the eighteenth with those of the early part of the nineteenth century shows that improvement in sanitation and in the general conditions of life has not had a corresponding effect on infectious diseases such as measles and whooping cough, which are diseases of childhood as small-pox was in pre-vaccination days. There has not been a decline in the mortality from these diseases comparable to the decline in small-pox mortality. See Appendix III.

The Influence of Small-pox Hospitals.—There can be no doubt that the system of immediate isolation in hospital of the first cases of small-pox that may occur in a district, when associated with prompt vaccination of contacts, has proved of great value in limiting the spread of the disease. The true nature of the “first cases” of small-pox, however, is not always recognised at once: comparatively few of the present generation of medical practitioners have had opportunity of observing and studying cases of the malady. It is well known that small-pox hospitals situated in or near populous districts may cause spread of the disease in their vicinity, and that such hospitals should be placed in sparsely populated localities. This has been demonstrated in the past in the case of London and other districts with the result that in 1885 the London small-pox hospitals were removed outside the Metropolitan area. Sanitary authorities have not provided, nor could they afford to provide, small-pox hospital accommodation on a scale sufficient for the reception of all the cases of small-pox that might arise during epidemic periods in a population entirely unprotected by vaccination.

Protection afforded by Vaccination against Small-pox.

Primary Vaccination.—When the operation of vaccination was first introduced it was thought that the resulting vaccinia would afford protection against attack by small-pox to the same extent as an attack by the natural or inoculated small-pox, *i.e.*, except in rare instances, for life. The experience of a century has shown that this is not the case. It is probable that the effect of vaccination to modify an attack by small-pox never entirely disappears, and while three weeks to a month after successful vaccination its power to prevent an attack by small-pox is at its maximum, its protective power to modify the character of the disease and to render it less fatal wanes with lapse of time, and the operation should be repeated at the end of a certain number of years.

Re-vaccination.—It is not possible to say with any certainty the exact date on which each vaccinated person should be re-vaccinated; so much depends on the degree of efficiency with which the primary vaccination has been performed and the personal susceptibility of the individual to the disease. It can be stated that although vaccinated persons under ten years have contracted small-pox, such attacks have been as a rule very mild and a fatal issue has rarely occurred. For the great majority of persons it will suffice to renew the vaccination at the end of ten years. This view is based on the experience derived from infantile vaccination.

Effect of Compulsory Re-vaccination on Small-pox Mortality of a Population.—Re-vaccination has never been compulsory in this country, but it was made compulsory in the civil population of Prussia and in German States by law in 1874, and its effect on the small-pox mortality in Prussia and the cities of Berlin and Hamburg can be compared with other places where re-vaccination was voluntary. This comparison is shown in the following table:—

SMALL-POX DEATH-RATES PER 100,000

(for a period of twelve years).

—	London.	Paris.	Vienna.	Austria.	Prussia.	Berlin.	Hamburg.
1870	30·2	546·0	46·7	30·3	17·5	22·4	25·0
1871	242·2	?	74·9	39·0	243·2	632·6	1,075·0
1872	53·8	5·5	537·0	190·0	262·4	138·6	95·3
1873	3·5	0·9	228·5	323·4	33·7	11·2	0·9
1874	1·6	2·5	135·3	178·2	9·5	2·5	0·6
					Compulsory re-vaccination in force after 1874.		
1875	1·3	13·7	113·5	57·7	3·6	5·2	0·0
1876	20·8	20·1	167·8	39·3	3·1	1·8	1·8
1877	71·0	6·8	84·1	53·0	0·3	0·4	1·3
1878	38·8	4·5	75·9	61·0	0·7	0·8	0·2
1879	12·1	45·8	46·9	50·9	1·3	0·8	0·0
1880	12·5	103·9	73·5	64·3	2·6	0·8	0·0
1881	61·9	49·4	124·0	83·0	3·6	4·7	2·2

Number and Area of Vaccination Marks as a Guide to Efficiency of Vaccination.—The efficiency with which vaccination is performed has an important bearing on the protection afforded to the vaccinated person against attack or death by small-pox. The number, area and character of the vaccination marks have an important bearing on the degree and permanence of the protection afforded.

This has been indicated in the statistics of small-pox hospitals, of which those of the Fulham Hospital for the years 1880 to 1885 show that in regard to the vaccinated cases at all ages the fatality was—

1 mark	-	-	-	-	10·37 per cent.
2 marks	-	-	-	-	8·73 „
3 marks	-	-	-	-	7·45 „
4 marks and upwards	-	-	-	-	4·23 „

The fatality in the unvaccinated was 46·08 per cent.

The return of the Metropolitan Asylums Board for the small-pox epidemic in London in 1901–2, respecting this matter, furnishes the following information:—

—		Admission.	Deaths.	Mortality, Per Cent.
Vaccinated cases :—				
Area of Cicatrices.	{ Half square inch and upwards	5,163	379	7·34
	{ One-third, but less than half, square inch.	835	131	15·69
	{ Less than one-third square inch	860	162	16·87
	{ Not recorded - - - -	87	33	37·93
Totals of vaccinated cases - - -		6,945	705	10·15
Unknown and doubtful class - - -		436	171	39·22
Unvaccinated class - - - -		2,277	752	33·06
GRAND TOTALS - - -		9,658	1,628	16·87

Alteration of the Age Incidence of Small-pox Mortality after the Introduction of Vaccination.—In an unvaccinated community the special incidence of small-pox fatality falls on children under five years of age, whereas in a community in which infantile vaccination is thoroughly and completely carried out and the protection of this primary vaccination which lapse of time diminishes is not restored by re-vaccination, the fatality rate of small-pox is transferred to the later period of life, the deaths occurring principally among persons of 40 years of age and upwards.

This fact emphasises the importance of the renewal by re-vaccination of the protection against small-pox in order to ensure the highest degree of protection that vaccination can afford.

Vaccination Administrative Arrangements.

In 1889 a Royal Commission was appointed to inquire into the whole subject of vaccination, the terms of the reference being very wide and far reaching. The inquiry was a prolonged one, several reports were issued, and the final report was

not made until 1896. The present vaccination administrative arrangements are based largely on the report of this Commission.

At the time of the passing of the first Vaccination Act in 1840 the only local authorities that exercised jurisdiction throughout England and Wales were the Poor Law guardians, and the administration of the Vaccination Law was entrusted to and remains with them, subject to the control of the Central Authority (now the Ministry of Health). The board of guardians appoint medical men to act as "public vaccinators" in their districts, and officers to keep the vaccination registers and to issue the necessary notices with reference to vaccination; these latter officers are called "vaccination officers," and their appointment was not made compulsory until 1871.

The instructions of the Ministry of Health to public vaccinators direct that, except in so far as any immediate danger of small-pox may require, the public vaccinator must vaccinate only subjects who are in good health.

As regards infants, he must ascertain that there is not any febrile state, nor any irritation of the bowels, nor any unhealthy state of the skin, especially no chafing or eczema behind the ears or in the groin or elsewhere in the folds of the skin. He must not, except of necessity, vaccinate in cases where there has been recent exposure to the infection of disease such as measles, scarlatina or diphtheria, nor where erysipelas is prevalent in or about the place of residence.

The public vaccinators are instructed to aim at producing four vesicles or groups of vesicles having a total area of half a square inch on the eighth day after the operation has been performed. By making four small marks separated as widely as possible from one another there is less likelihood of "bad arms" resulting and a maximum efficacy in protection against small-pox is afforded.

By the terms of his contract the public vaccinator is required to afford medical attendance without cost to the parent in cases in which the vaccination does not run an ordinary course and where, owing to supervening illness, such attendance becomes necessary.

The arrangements in operation for vaccination throughout the country are as follows:—When the birth of a child is registered the registrar gives to the parent or other person who registers the birth of the child a notice on which is set forth the legal requirement and the steps to be taken in regard to vaccination. The parents can fill in the form requesting the public vaccinator to call and vaccinate the child, or can obtain legal exemption from vaccination by making a statutory declaration before a justice of the peace or commissioner of oaths, or can arrange for the child to be vaccinated by a private medical practitioner. The vaccination register is kept by the vaccination officer, who receives the list of births from the registrar

of births. When a child has reached a certain age and the vaccination officer has not received a certificate that the child has been vaccinated, a certificate of exemption from vaccination, or a medical certificate of postponement on account of illness of the child, he warns the parent that the time for complying with the law is running out, and he calls at the house of the child to explain the position. If he finds that the child has not been vaccinated nor legally exempted, he sends the name and address of the child to the public vaccinator, who calls at the house and offers to vaccinate the child. If this offer is refused and the child remains unvaccinated, it is the duty of the vaccination officer to issue a notice to the parent warning him that he is in default with respect to the vaccination of his child, and if this notice is disregarded the vaccination officer should take legal proceedings against the parent.

When the public vaccinator calls at its home he offers to vaccinate the child with lymph supplied by the Government Lymph Establishment, and the parent has the right to demand that this lymph shall be used.

About 65 per cent. of the primary vaccinations of children are performed by the public vaccinators.

The Government Lymph Establishment.—The Government Lymph Establishment was specially designed and built for the production of vaccine lymph. Selected calves are received here, kept under observation for some days, and dieted. Any calves exhibiting symptoms of sickness are rejected, and the healthy calves are vaccinated with the current "seed" lymph of the establishment. When the lymph has been collected from the vaccinated calves, these calves are removed to a slaughter-house, killed, and the carcase carefully examined by a qualified veterinary surgeon. In the event of this post-mortem examination showing that the calf is diseased, the lymph taken from that calf is at once destroyed.

The lymph after collection is treated with glycerin and certain preservatives, and is examined at intervals to ascertain its freedom from extraneous micro-organisms, and is kept in cold storage at a temperature of 10° Fahr.

At every stage the production of the lymph is carried out under the direct supervision of the medical superintendent and a staff of trained medical and lay assistants, and no lymph is issued for public vaccination unless and until all the precautionary tests have been applied and satisfied.

It is the custom to send out the lymph from the Government Lymph Establishment in capillary tubes, each tube containing sufficient lymph for a single vaccination, and the public vaccinators are instructed that once a tube has been opened it should not be re-sealed. The greatest care is taken at every stage in the production of the lymph, and every public vaccinator is required to report on the result of every tube used by him.

The high standard of excellence of the lymph is shown by the results; in 1920 this lymph when used for primary vaccination in 262,998 cases gave a case success of 99·4 per cent. and an insertion success of 96·3 per cent.

The present State of the Vaccination of the Population of England and Wales.

It must be borne in mind that the compulsory clauses of the Vaccination Acts of this country relate only to the primary vaccination of children; re-vaccination is left entirely optional, but gratuitous vaccination is provided for older persons and re-vaccination for those who wish to renew their protection against small-pox.

The Vaccination Act of 1898 was passed with the object of giving a trial to improved methods of applying vaccination. It was considered that it would conduce to increased vaccination if arm to arm vaccinations were replaced by vaccination performed with specially prepared calf lymph and if children, instead of being brought to a vaccination station to be vaccinated, were vaccinated in their homes. At the same time, it was believed that the scheme would give effect to the recommendations of the Royal Commission on Vaccination; while it retained in a somewhat modified form the penalty clauses in operation to prevent children remaining unvaccinated owing to the neglect or indifference of their parents, it allowed a parent who conscientiously believed that vaccination would be prejudicial to the health of his child to escape penalty (for not procuring his child's vaccination) by satisfying two justices or a stipendiary or metropolitan police magistrate in petty sessions of his conscientious belief, and delivering a certificate to that effect to the vaccination officer.

This Act was described by Lord Lister in the House of Lords as a "tremendous experiment," and Parliament provided that it should operate for five years. It has, however, been renewed from year to year by the Expiring Laws Continuance Acts.

It came into operation in the year 1899, but certificates of "conscientious objection" became registrable from 12th August 1898. In the year 1899, there were 929,189 births, 617,113 primary vaccinations of infants, and 33,573 children legally exempted from vaccination, *i.e.*, the percentages of vaccinations and of exemptions to births were 66·4 and 3·6 respectively.

Difficulty arose in the working of the Act from the varying views of justices as to their powers and duties in relation to the granting of certificates of conscientious objection, and in 1907 an Act was passed to enable the conscientious objector to obtain the exemption certificate by making a statutory declaration of his objection (*see* page 9). This certificate may be obtained by the father only, if father and mother are both living and in charge of the child, but this limitation is not universally understood, and many certificates have been obtained by married

women living with their husbands. The Act of 1907 came into operation on 1st January 1908, and its immediate effect was to more than double the number of exemptions. In 1908 there were 940,640 births, the exemptions rose to 160,350 or 17·0 per cent. and the number of primary vaccinations fell to 594,792 or 63·2 per cent. Since that time the percentage of vaccinations to births has decreased and the percentage of exemptions to births has increased. In the year 1919, the last year for which the figures are available, the births numbered 691,370 and the primary vaccinations 281,029 or 40·6 per cent. and the exemptions were 277,558 or 40·1 per cent. The statistics for the years in question are given in full on pages 13 and 14, and it will be seen that in the last ten years, 1910 to 1919, when allowance is made for those who have died, there still remain over two-and-a-half million children under twelve years of age who are legally exempted from vaccination and are unprotected against attack and death from small-pox, and that by the operation of the existing law a further quarter of a million are added to this number year by year. This is a fact that should be known, and when it is borne in mind that in pre-vaccination days the incidence of attack and death from small-pox fell chiefly on young children, its significance can be duly appreciated and the tragedy of a widespread epidemic of small-pox realised.

At the present time a considerable proportion of the adult male population is protected, owing to having been re-vaccinated while serving in the navy and army during the war. The adult female population is protected to a lesser extent, although many women who served in the auxiliary corps were re-vaccinated.

It is not possible to state what proportion of the total population of this country has been re-vaccinated, inasmuch as re-vaccination is voluntary. There are no official records of the number of re-vaccinations performed, except those done by public vaccinators, and these refer mainly to persons who desire to enter a service in which re-vaccination is compulsory or who wish to travel abroad in countries where only persons who have been recently successfully re-vaccinated are permitted to enter. The proportion of re-vaccinated persons in a population rapidly rises when small-pox breaks out, and when small-pox is epidemic the demand for re-vaccination at times becomes very great. The operation of vaccination should be carefully carried out in the quietness of the home and without any undue haste. This is impossible during the rush of a small-pox epidemic, and this "panic" vaccination is apt to be followed by bad arms and untoward results.

Such results can all be avoided provided that persons avail themselves of the opportunity to be vaccinated when small-pox is not prevalent.

Injuries resulting from Vaccination.—The use of specially prepared calf vaccine lymph obviates any risk of transference

Year.	Births.	Vaccinated.	Percentage of Vaccinations to Births.	Insusceptible.	Had Small-pox.	Exempted.	Died.	Postponed.	Remaining.	Not accounted for (including Cases postponed), Percentage of Births.
1898	923,059	562,059	61·0	3,232	4	47,423	110,912	16,921	181,830	21·5
			The Vaccination Act,		1898, came into operation on		on 1st January 1899.			
1899	929,189	617,113	66·4	5,379	4	33,573	113,516	16,605	142,999	17·2
1900	927,222	636,940	68·7	2,261	2	39,699	103,538	14,225	130,557	15·6
1901	929,882	664,366	71·4	2,631	27	39,925	102,007	12,317	108,609	13·0
1902	940,509	703,721	74·8	3,027	27	33,759	90,826	12,213	96,936	11·6
1903	948,383	714,637	75·4	2,573	17	37,675	91,754	12,489	89,238	10·7
1904	945,500	711,504	75·3	2,676	22	40,461	94,686	12,723	83,428	10·2
1905	929,540	705,040	75·8	2,252	8	44,369	84,712	13,175	79,984	10·0
1906	935,338	686,992	73·4	2,203	6	53,828	88,553	14,376	89,380	11·1
1907	918,341	651,050	70·9	1,926	1	76,709	78,513	14,916	95,226	12·0
			The Vaccination Act,		1907, came into operation on		on 1st January 1908.			
1908	940,640	594,792	63·2	2,438	2	160,350	80,188	14,333	88,537	10·9
1909	914,844	547,279	59·8	2,280	1	197,342	70,388	13,919	83,635	10·7
1910	897,273	501,638	55·9	1,592	0	233,677	67,768	12,702	79,896	10·3
1911	881,159	460,598	52·3	2,492	0	250,798	75,066	12,053	80,152	10·5
1912	872,799	436,951	50·1	1,367	0	280,529	60,238	12,552	81,162	10·7
1913	882,261	410,094	46·5	1,003	1	310,717	67,141	12,705	80,600	10·6
1914	878,901	381,690	44·6	1,453	1	320,421	65,626	13,426	86,284	11·3
1915	814,825	370,763	45·5	836	4	291,787	57,184	13,244	81,007	11·6
1916	785,397	350,975	44·7	1,200	0	290,515	51,582	12,910	78,215	11·6
1917	668,815	289,917	43·3	1,114	1	253,291	44,249	10,837	69,406	12·0
1918	662,900	274,880	41·5	1,420	1	248,885	44,693	11,760	81,261	14·0
1919	691,370	281,029	40·6	1,058	2	277,558	44,061	12,295	75,367	12·7

“ABSTENTION” from VACCINATION and “ACCEPTANCE” of VACCINATION in 1893-97 and in subsequent Years.

	Per cent. of Births in each instance.																						
	1893 to 1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	1919.
—																							
Abstention (“Exempted,” “postponed” and “remaining”) :— England and Wales (including London).	21·0	26·6	20·8	19·9	17·5	15·2	14·7	14·5	14·8	16·9	20·4	27·9	32·3	36·4	38·9	42·8	45·8	47·8	47·4	48·6	49·9	51·6	52·8
London . . .	23·9	34·4	28·7	26·8	25·2	22·1	21·7	20·2	20·1	22·7	25·8	28·8	30·7	34·1	36·6	41·0	52·5	46·6	44·9	46·1	47·2	47·3	48·4
(Exemptions alone) :— England and Wales (including London).	—	5·1	3·6	4·3	4·5	3·6	4·0	4·3	4·8	5·8	8·4	17·0	21·6	26·1	28·5	32·1	35·2	36·5	35·8	38·0	37·9	37·5	40·1
London . . .	—	1·4	1·0	1·0	1·1	0·8	1·8	1·1	1·2	1·5	3·1	7·3	10·1	13·6	15·8	20·0	23·8	25·2	22·9	24·7	24·5	22·5	27·7
Acceptance (Vaccinated) :— England and Wales (including London).	67·7	61·0	66·4	68·7	70·8	74·8	75·4	75·3	75·8	73·4	70·9	63·2	59·8	55·9	52·3	50·1	46·5	44·6	45·5	44·7	43·3	41·5	40·6
London . . .	65·4	53·8	58·8	61·7	64·3	68·0	68·9	69·7	70·7	68·1	65·9	63·0	61·7	58·4	54·8	52·2	48·3	45·8	48·0	47·4	45·6	45·7	45·0

to the vaccinated persons of the hereditary diseases of man, and the immediate slaughter and examination of the calves after the collection of the lymph and the subsequent bacteriological examination of the lymph during its preparation excludes any malady that may affect the bovine animal. From time to time deaths are certified as connected with vaccination. In the nine years 1911-19, 68 such certificates have been received by the Registrar-General, and during this period 3,266,897 primary vaccinations of children have been recorded. These figures would represent one death for every 48,043 vaccinations. Such a certificate does not always mean that the disease which ended fatally had its origin in vaccination; it may merely indicate that the child had been vaccinated shortly before its death, and that the death is really attributable to some concurrent illness. For instance, a child may contract measles while undergoing vaccination, and the immediate cause of death may be a complication of measles such as bronchopneumonia. Nevertheless a vaccination wound is, like one from any other cause, so long as it exists, a source of some risk, and accidental contamination of the vaccinated surface through rupture of the vesicles may occur. Such calamities are not limited to vaccination: even very slight wounds induced by scratches from pins, abrasions from dress or other injuries, in themselves most trivial, may lead to poisoning. In certain instances there has been lack of care and attention on the part of the mother or other person in charge of the child, or cream or other objectionable substance has been applied to the vaccinated surface under circumstances which made it a source of danger. It is most important that any rags, dressings, or other materials applied to the place of vaccination should be scrupulously clean, and no application of any sort should be applied to the vaccinated surface except on medical advice.

If these simple precautions are adhered to vaccination can be said to be free of risk to the health of the child.

Summary.—We know that the mortality from small-pox is much less now than in pre-vaccination times, that the greatest diminution in the small-pox mortality is found in the early years of life in which there is most vaccination; that in countries in which there is much vaccination and re-vaccination relatively to the population, there is little small-pox; that in places where small-pox prevails it attacks a much greater proportion of the unvaccinated than the vaccinated, especially where the vaccinations are comparatively recent; that in houses invaded by small-pox in the course of an outbreak not nearly so many of the vaccinated inmates are attacked as of the unvaccinated in proportion to their numbers; that the fatality rate among persons attacked by small-pox is much greater age for age among the unvaccinated than among the vaccinated; that the degree of protection conferred by vaccination corresponds to the thoroughness with which the

operation has been performed, four marks affording much better protection than one or two; that the protection afforded by vaccination wanes with lapse of time; that improved sanitation, however beneficial in itself, cannot account for these facts; and that though early diagnosis, prompt isolation of small-pox patients in suitable hospitals, effective disinfection, supervision of "contacts," and other such public health measures, are invaluable, they are no substitute for vaccination.

MINISTRY OF HEALTH,
WHITEHALL,
August 1921.

APPENDIX I.

ENGLAND AND WALES. MORTALITY FROM SMALL-POX AND CHICKEN-POX.

Year.	Popula- tion.	Number of Deaths from Small-pox (with those Returned as from Chicken-pox).	Deaths from Small-pox (with those Returned as from Chicken-pox) to every 100,000 living.	Year.	Popula- tion.	Number of Deaths from Small-pox (with those Returned as from Chicken-pox).	Deaths from Small-pox (with those Returned as from Chicken-pox) to every 100,000 living.				
1838	15,287,699	16,268	106	1847	17,150,018	4,227	25				
1839	15,514,255	9,131	59	1848	17,356,882	6,903	40				
1840	15,730,813	10,434	66	1849	17,564,656	4,644	26				
1841	15,929,492	6,368	40	1850	17,773,324	4,665	26				
1842	16,130,326	2,715	17	1851	17,982,849	6,997	39				
1843	16,332,228	Causes of death not abstracted by Registrar- General.		1852	18,193,206	7,320	40				
1844	16,535,174			1853	18,404,368	3,151	17				
1845	16,739,136			1854	18,616,310	2,808	15				
1846	16,944,092										
Year.	Popula- tion.	Small-pox.		Chicken-pox.		Year.	Popula- tion.	Small-pox.		Chicken-pox.	
		Deaths.	Rate per 100,000.	Deaths.	Rate per 100,000.			Deaths.	Rate per 100,000.	Deaths.	Rate per 100,000.
1855*	18,829,000	2,469	13.1	51	0.3	1888	28,136,258	1,026	3.7	116	0.4
1856*	19,042,412	2,215	11.6	55	0.3	1889	28,448,239	23	0.1	83	0.3
1857	19,256,516	3,882	20.2	54	0.3	1890	28,763,673	16	0.0	95	0.3
1858*	19,471,291	6,414	32.9	40	0.2	1891	29,085,819	49	0.2	91	0.3
1859*	19,686,701	3,798	19.3	48	0.2	1892	29,421,392	431	1.5	123	0.4
1860	19,902,713	2,713	13.6	36	0.2	1893	29,760,842	1,457	4.9	127	0.4
1861	20,119,314	1,290	6.4	30	0.1	1894	30,104,201	820	2.7	108	0.4
1862	20,371,013	1,579	7.8	49	0.2	1895	30,451,528	223	0.7	86	0.3
1863	20,625,855	5,891	28.6	73	0.4	1896	30,802,858	541	1.7	151	0.5
1864	20,883,889	7,624	36.4	60	0.3	1897	31,158,245	25	0.0	103	0.3
1865	21,145,151	6,361	30.1	50	0.2	1898	31,517,725	253	0.8	116	0.4
1866	21,409,684	2,977	13.9	52	0.2	1899	31,881,365	174	0.5	124	0.4
1867	21,677,525	2,467	11.4	46	0.2	1900	32,249,187	85	0.3	127	0.4
1868	21,948,713	1,994	9.1	58	0.3	1901	32,612,022	356	1.0	115	0.4
1869	22,223,299	1,482	6.7	83	0.4	1902	32,950,909	2,464	7.5	123	0.4
1870	22,501,316	2,547	11.3	73	0.3	1903	33,293,321	760	2.3	116	0.3
1871	22,788,594	23,062	101.2	64	0.3	1904	33,639,287	507	1.5	104	0.3
1872	23,096,495	19,022	82.1	72	0.3	1905	33,988,844	116	0.4	93	0.3
1873	23,408,556	2,303	9.8	61	0.3	1906	34,342,040	21	0.1	106	0.3
1874	23,724,834	2,084	8.8	78	0.3	1907	34,698,905	10	0.0	120	0.3
1875*	24,045,385	849	3.5	101	0.4	1908	35,059,484	12	0.0	93	0.3
1876*	24,370,267	2,408	9.9	109	0.4	1909	35,423,805	21	0.0	94	0.3
1877*	24,699,539	4,278	17.3	110	0.4	1910	35,791,902	19	0.0	97	0.3
1878*	25,033,259	1,856	7.4	106	0.4	1911	36,189,685	23	0.0	80	0.2
1879*	25,371,489	536	2.1	89	0.4	1912	36,382,456	9	0.0	76	0.2
1880*	25,714,288	648	2.5	103	0.4	1913	36,606,226	10	0.0	83	0.2
1881	26,046,142	3,098	11.9	133	0.5	1914	36,960,684	4	0.0	122	0.3
1882	26,334,942	1,317	5.0	122	0.5	1915	35,358,896†	13	0.0	92	0.3
1883	26,626,949	957	3.6	99	0.4	1916	34,500,000†	18	0.0	65	0.2
1884	26,922,192	2,234	8.2	129	0.5	1917	33,711,000†	3	0.0	69	0.2
1885	27,220,706	2,827	10.3	109	0.4	1918	33,474,700†	2	0.0	54	0.2
1886	27,522,532	275	1.1	93	0.3	1919	36,800,000	28	0.1	55	0.1
1887	27,827,706	506	1.9	87	0.3	1920	37,609,600	30	0.1	71	0.2

* The numbers shown in the Report of the Royal Commission on Vaccination include deaths from the following causes:—

1895 (5 from miliaria); 1856 (7 from miliaria); 1858 (6 from miliaria); 1859 (2 from miliaria); 1875 (2 from miliary fever); 1876 (1 from miliary fever); 1877 (4 from miliary fever, 3 from cow-pox); 1878 (4 from miliary fever, 4 from cow-pox); 1879 (2 from miliary fever, 4 from cow-pox); 1880 (1 from miliary fever, 2 from cow-pox).

† For the year 1915-1918 the populations and death rates refer to civilians only. The numbers of deaths, however, include those of non-civilians registered in this country.

APPENDIX II.

LONDON: MORTALITY FROM SMALL-POX, 1838-1920.

Note.—The boundaries of the Administrative and Registration Counties of London were made co-extensive in 1901. Previous to that year the figures in the table relate to the Registration County as constituted at the several dates.

Year.	Population.	Number of Deaths from Small-pox.	Deaths from Small-pox to every 100,000 living.	Year.	Population.	Number of Deaths from Small-pox.	Deaths from Small-pox to every 100,000 living.
1838	1,766,469	3,817	216	1880	3,771,139	471	12
1839	1,802,751	634	35	1881	3,824,980	2,367	62
1840	1,840,091	1,235	67	1882	3,862,956	430	11
1841	1,878,205	1,053	56	1883	3,901,309	136	3
1842	1,917,108	360	19	1884	3,940,042	1,236	31
1843	1,954,041	438	22	1885	3,979,160	1,419	36
1844	2,033,816	1,804	89	1886	4,018,666	24	0·6
1845	2,073,298	909	44	1887	4,058,565	9	0·2
1846	2,113,535	257	12	1888	4,098,860	9	0·2
1847	2,202,673	955	43	1889	4,139,555	0	0·0
1848	2,244,837	1,620	72	1890	4,180,654	4	0·1
1849	2,287,302	521	23	1891	4,223,720	8	0·2
1850	2,330,054	499	21	1892	4,269,634	29	0·7
1851	2,373,081	1,062	45	1893	4,312,263	186	4·3
1852	2,416,367	1,159	48	1894	4,351,501	89	2·1
1853	2,459,899	211	9	1895	4,387,248	55	1·3
1854	2,503,662	694	28	1896	4,419,411	9	0·2
1855	2,547,639	1,039	41	1897	4,447,907	16	0·4
1856	2,591,815	531	20	1898	4,472,664	1	0·0
1857	2,636,174	156	6	1899	4,493,617	3	0·1
1858	2,680,700	242	9	1900	4,510,711	4	0·1
1859	2,725,374	1,158	42	1901	4,536,201	229	5·1
1860	2,770,181	898	32	1902	4,534,828	1,314	28·5
1861	2,815,101	217	8	1903	4,533,443	13	0·3
1862	2,860,117	366	13	1904	4,531,856	25	0·6
1863	2,905,210	1,996	69	1905	4,530,418	10	0·2
1864	2,950,361	547	18	1906	4,528,964	—	—
1865	2,995,551	640	21	1907	4,527,495	—	—
1866	3,040,761	1,391	46	1908	4,525,847	—	—
1867	3,085,971	1,345	44	1909	4,524,346	2	0·0
1868	3,131,160	597	19	1910	4,522,832	—	—
1869	3,176,308	275	9	1911	4,521,194	9	0·2
1870	3,221,394	973	30	1912	4,520,401	1	0·0
1871	3,267,251	7,912	242	1913	4,519,480	—	—
1872	3,319,736	1,786	54	1914	4,518,021	—	—
1873	3,373,065	113	3	1915*	4,310,030	3	0·1
1874	3,427,250	57	2	1916*	4,237,387	—	—
1875	3,482,306	46	1	1917*	4,026,901	—	—
1876	3,538,246	736	21	1918*	3,954,554	—	—
1877	3,595,085	2,551	71	1919*	4,358,309	6	0·1
1878	3,652,837	1,417	39	1920*	4,531,971	2	0·0
1879	3,711,517	450	12				

* For the years 1915 onwards the figures relate to civilians only.

The deaths shown in this table are those of residents of the county.

The figures for 1892 and 1893 differ from those given on page 32 of the Report of the Royal Commission on Vaccination, the latter having been only partially corrected. Similar differences occur in 1885, 1886, 1889 and 1890, the fully corrected numbers for these years being 1,317; 20; 1 and 3.

APPENDIX III.

ENGLAND AND WALES: MORTALITY FROM SMALL-POX, MEASLES
AND WHOOPING COUGH PER MILLION LIVING.

Year.	Small- pox.	Measles.	Whooping Cough.	Year.	Small- pox.	Measles.	Whooping Cough.
1838	1,064	426	596	1880	25	478	530
1839	589	705	526	1881	119	280	415
1840	661	591	389	1882	50	483	579
1841	400	433	508	1883	36	350	393
1842	168	542	502	1884	82	419	425
1843	—	—	—	1885	103	533	481
1844	—	—	—	1886	11	436	470
1845	—	—	—	1887	19	602	404
1846	—	—	—	1888	37	347	436
1847	246	507	540	1889	1	518	430
1848	397	395	394	1890	0	439	478
1849	264	311	548	1891	2	436	468
1850	262	398	437	1892	15	459	454
1851	389	521	440	1893	49	373	342
1852	401	320	440	1894	27	391	410
1853	171	266	609	1895	7	377	315
1854	151	498	525	1896	17	570	429
1855	131	391	541	1897	0	408	367
1856	116	373	483	1898	8	419	323
1857	202	310	526	1899	5	314	318
1858	329	476	598	1900	3	394	356
1859	193	485	456	1901	10	277	313
1860	136	479	429	1902	75	392	298
1861	64	450	612	1903	23	275	286
1862	78	481	602	1904	15	365	353
1863	286	550	547	1905	4	326	256
1864	364	397	409	1906	1	275	242
1865	301	405	409	1907	0	364	296
1866	139	511	736	1908	0	228	280
1867	114	304	548	1909	0	356	203
1868	91	528	419	1910	0	232	246
1869	67	464	493	1911	1	363	217
1870	113	335	529	1912	0	352	230
1871	1,012	408	455	1913	0	291	149
1872	821	368	596	1914	0	247	218
1873	98	316	411	1915*	0	462	230
1874	88	517	437	1916*	0	155	176
1875	35	257	594	1917*	0	308	134
1876	99	408	432	1918*	0	289	296
1877	173	366	460	1919†	1	96	71
1878	74	310	711	1920†	1	191	117
1879	21	362	503				

*Among civilian population only.

† Subject to revision.

Note.—The rates for the years 1911–1920 are based upon provisional estimates of population.

